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APPLICATION FOR
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SHAKER SCREEN AND CLAMPING SYSTEM

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SHAKER SCREEN AND CLAMPING SYSTEM

BACKGROUND OF THE INVENTION

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Related Applications

This is a continuation-in-part of U.S. Application Ser. No. 10/057,755 filed 01/23/02 which is incorporated fully herein for all purposes.

Field Of The Invention

10 1. The present invention is directed generally to: mounting systems for screen assemblies used in vibratory separators; such screen assemblies; vibratory separators and shale shakers; in one particular aspect to a selectively operable powered system for holding and clamping screen assemblies in shale shakers used for 15 treating drilling fluids; and methods of use of these things.

Description of Related Art

20 2. The prior art discloses a variety of vibratory separators and shale shakers. Vibratory separators are used in a wide variety of industries to separate materials such as liquids from solids or solids from solids. Typically such separators have a basket or other screen holding or mounting apparatus mounted in or over a receiving receptacle or tank and vibrating apparatus for vibrating the basket. One or more screens is mounted in the basket. 25 Material to be treated is introduced to the screen(s) either by flowing it directly onto the screen(s) or by flowing it into a container, tank, or "possum belly" from which it then flows to the screen(s). Also in some multi-screen apparatuses material flows from an upper screen onto a lower screen.

30 The prior art discloses a variety of mounting systems and apparatuses for releasably mounting a screen assembly to a shale shaker. These include drawbar and hookstrip apparatuses; inflatable

device systems; wedge systems; e.g. the systems described in U.S. Patents 6,179,128 issued Jan 30, 2001; 5,392,925 issued Feb. 28, 1995; 4,882,054 issued Nov. 21, 1989; 4,582,597 issued Apr. 15, 1986; and in the prior art referred to in each of these references.

Referring now to Fig. 5, a prior art shale shaker 1 has a screen 2 (with screen or screening cloth or mesh as desired) mounted on vibratable screen mounting apparatus or "basket" 3. The screen 2 may be any known screen or screens. The basket 3 is mounted on springs 4 (only two shown; two as shown are on the opposite side) which are supported from a frame 6. The basket 3 is vibrated by a motor 5 and interconnected vibrating apparatus 8 which is mounted on the basket 3 for vibrating the basket and the screens. Elevator apparatus 7 provides for raising and lowering of the basket end.

Fig. 6 discloses an example of a prior art shaker system (e.g. as shown in U.S. Patent 5,190,645 incorporated fully herein for all purposes). The system A has a shale shaker K having a screen or screens S. The screen(s) S are mounted in a typical shaker basket B and one or more vibrators V (any known suitable shaker vibrator) vibrate the basket B and hence the screen(s) S. The other components of the system A are as described in U.S. Patent 5,190,645.

The prior art discloses a variety of screen assemblies and of screen assembly mounting systems for holding screen assemblies in vibratory separators, for releasably clamping such screen assemblies in position, for maintaining such screen assemblies in position during operation of the separators, and, in certain apparatuses, for providing desired tension on screening material that is part of a screen assembly. Since the screening material of these screen assemblies wears, tears, and degrades during use, it is desirable that the screen assembly mounting systems provide for easy installation, removal, and replacement of screen assemblies.

U.S. Patents 3,968,033; 4,846,352; 5,226,546; 4,224,146;

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4,744,898; 6,179,128; 4,040,951; 4,303,509; 5,332,101; 6,401,935; 3,718,963; and 2,630,225 (all incorporated fully herein) and the references cited ther in provide a variety of separators, shakers, and mounting systems for screen assemblies therein.

5. 4. There has long been a need, recognized by the present inventors, for a fast and efficient way to replace screen assemblies in a vibratory separator or shale shaker. There has long been a need, recognized by the present inventors, for a way to change out a screen assembly without shutting down a wellbore 10 operation which employs the separator or shaker. There is a need, recognized by the present inventors, for an efficient and effective screen mounting structure and method for screen assemblies for shale shakers. There is a need, recognized by the present inventor, for an efficient and stable mounting of screens to a 15 shale shaker.

SUMMARY OF THE PRESENT INVENTION

5. The present invention, in certain aspects, provides a 20 clamping system for releasably holding a screen assembly in place during operation of a vibratory separator or shale shaker. The system, in one aspect, has a screen mounting apparatus or basket with one or more rails and, in one aspect, two spaced-apart rails, one for each of two sides of a four sided screen assembly. The 25 rails are configured and positioned to be pushed down on the sides of the screen assembly. Each side of the screen assembly is on a support or ledge along the sides of a vibratory separator. The rail's bottom surface, in one aspect, contacts an upper surface of an upper layer of screening material on the screen assembly. One 30 or more selectively operable powered pistons pushes down on the rail to clamp the screen assembly against the support or ledge. The pistons may be hydraulically, electrically or pneumatically powered. Such power may be provided by dedicated portable power

sources and/or by existing power sources, e.g. existing power sources on a drilling rig or at a job site.

6. The piston mechanisms themselves are, in one aspect, connected to a side or wall of a vibratory separator or shale shaker, and are, in one aspect, connected to a bar that is bolted to a basket or screen mounting structure. In one aspect, such rails are mounted on side walls of a screen mounting basket of a shale shaker.

7. In one particular aspect a pin or pins of a support or deck extend(s) up into corresponding hole(s) in the screen assembly. In one aspect, a screen assembly according to the present invention has four holes along two spaced-apart edges thereof and parts of deck pins project through these holes to hold the screen assembly in place. Such a screen assembly may include a typical support structure, including, but not limited to, a strip support, a perforated plate, and/or a frame, e.g., in one aspect a frame made of tubular members with or without crossmembers; while in another aspect such a screen assembly has no such support structure. In one particular embodiment the edge portions of a screen assembly have one or more holes through which extend a corresponding pin or pins that project upwardly from a ledge of the vibratory separator and/or shale shaker. In certain embodiments each ledge or support has an inclined surface and the rails - which are forced against the screen assembly by the downward force of the pistons - have an angled bottom surface that presses against the edges of the screen assembly forcing the edges against surfaces of the ledges to bend the screen assembly's edges thereby producing a "crowned" configuration that stretches and imparts tension to screening material on the screen assembly. Movable-member-top-of-screen contact can also effect a seal with the top of the screen assembly and between the screen assembly and the underlying support. Systems according to the present invention may also be

used with screen assemblies that are more rigid and have frames or other supports that do not bend.

8. In another aspect, in a system according to the present invention an inflatable bladder member (or members) is used to push down on a screen assembly to clamp the screen assembly in an operative position in a vibratory separator or shale shaker. In one aspect the bladder(s) are strong and powerful enough to bend a screen for tensioning of screening material. In one aspect the bladder(s) directly contact screening material of a screen assembly and rails as described above are used, while in another aspect such rails are not used.

9. In one aspect there is a deck or a series of spaced-apart ribs or supports under the screen assembly. Such ribs or supports can be curved with a desired curve producing a desired crowned shape and the screens are bent onto them to correspond to this curve.

10. It is, therefore, an object of at least certain preferred embodiments of the present invention to provide:

11. New, useful, unique, efficient, non-obvious screen assembly clamping systems, vibratory separators and shale shakers with such systems, and method of their use;

12. Such systems with one or more selectively operable movable members which releasably hold screen assemblies in place;

13. Such systems in which such a bladder or a rail directly contacts screening material of such a screen assembly;

14. Such systems which make possible the quick and easy replacement of screen assemblies on vibratory separators and shale shakers and/or effective sealing thereon;

15. Such systems which provide desired tensioning of screening material on screen assemblies;

16. The present invention discloses, in at least certain aspects, a screen assembly for a shale shaker, the screening assembly with one, two, three, four or more pins, studs, or fingers

projecting downwardly from a lower support, the pins, studs, members, or fingers ("projecting members") for insertion into a corresponding holes in a shale shaker screen assembly mounting tray, bed, or deck. Such pin(s), stud(s), and/or finger(s) provide
5 for correct emplacement and positioning of the screen assembly (or assemblies) on the shale shaker tray, bed, or deck and also stabilize the screen assembly or assemblies during operation of the shale shaker. The downwardly projecting member(s) may be formed integrally of a screen support (frame, strip support, perforated 10 plate, unibody structure) and/or they may be releasably attached to or connected to the support.

17. A shale shaker, in one embodiment according to the present invention (e.g. with basic components as the prior art shakers described or referred to herein) is, according to the 15 present invention, provided with one or more screen assemblies with such projecting members as described herein according to the present invention. Such a shaker has a hole or holes in its screen-mounting tray, bed or deck corresponding to the pin(s) and/or finger(s) of the screen assembly (or assemblies) mounted 20 thereon.

18. A screen assembly according to the present invention may be any known shale shaker screen or screen assembly to which the pin(s), stud(s), and/or finger(s) are added.

19. The present invention, in one embodiment includes a shale 25 shaker with a frame; a "basket" or screen mounting apparatus in the frame with a bed, tray or deck for a screen assembly or screen assemblies therein; pin(s) and/or finger(s) projecting up from the bed, tray or deck; one or more screen assemblies according to the present invention with a hole (or holes) corresponding to the 30 pin(s) and/or finger(s) of the deck, bed or tray; the one or more screen assemblies mounted to the basket with the pin(s) and/or finger(s) projecting into the corresponding hole or holes of the screen assembly or screen assemblies according to the present

invention; basket vibrating apparatus; and a collection tank or receptacle below the basket. In one particular aspect such a shale shaker treats drilling fluid with drilled cuttings, debris, etc. entrained therein. With such a shale shaker, the pin(s) and/or finger(s) of the deck, bed or tray can be formed integrally of the deck, bed or tray; or the pin(s) and/or finger(s) may be part of strips, bars, wear strips or elongated members that are releasably connectable to the deck, bed or tray. In one particular aspect, such pin(s) and/or finger(s) are on separate wear strips that are releasably connected to a shaker tray and which, in position thereon, provide an upward force that forces a screen assembly thereabove upwardly, facilitating the maintenance in position of the screen assembly. Wear strips that are made in an originally upwardly bowed configuration can provide such an upward force or an initially flat wear strip that is installed so that it bows slightly upwardly can provide such a force.

20. In other aspects of the present invention a hole or holes is or are provided in the upper surface of a support of a screen assembly (or in the lower surface of the support), e.g., but not limited to in part of a tubular frame of a screen assembly and a projecting member or members are moved into such hole or holes (e.g., a downwardly projecting member on a screen assembly holding member or structure or on an air bladder that is inflated above a screen assembly to secure it in place on a shaker deck, bed or tray or an upwardly projecting member on a screen assembly holding member or structure or on an air bladder that is inflated below a screen assembly to secure it in place on a shaker deck, bed or tray). In certain such aspects the screen assemblies shown in the drawings and described in detail below have the hole or holes in the topmost surface of a screen frame or tubular support rather than in the bottom thereof.

21. It is, therefore, an object of at least certain preferred embodiments of the present invention to provide:

22. New, useful, unique, efficient, non-obvious screen assemblies for shale shakers and methods for using them to separate components of material to be treated thereby;

5 23. Such screen assemblies, and shale shakers therewith, with one or more downwardly projecting members (e.g., studs, positioning pins or fingers) for releasably positioning and mounting such a screen assembly on a shale shaker mounting structure (bed, tray , deck); and

10 24. New, useful, unique, efficient, non-obvious shale shakers with one or more upwardly projecting members on the shaker's deck, bed or tray for insertion into corresponding hole(s) on a screen assembly support of a screen assembly to be mounted on the shaker.

15 New, useful, unique, efficient, non-obvious screen assemblies with a plurality of glued-together layers (e.g., one two, three or more) of screening material with at least one hole through the layers and through a plate on one side of the combination of layers of screening material, and, in one aspect, such a plate on both sides of the combination of glued-together layers of screening material; and in one aspect such a combination of glued-together 20 layers of screening material with a hook apparatus on one side or end thereof for selective tensioning in a shale shaker; and in one aspect such a screen assembly with one or more projecting members projecting from a plate on the top of or from a plate on the bottom of the screen assembly;

25 25. New, useful, unique, efficient, non-obvious wear strips for screen assembly mounting structures of shale shakers and methods for using them.

30 26. The present invention recognizes and addresses the previously-mentioned problems and long-felt needs and provides a solution to those problems and a satisfactory meeting of those needs in its various possible embodiments and equivalents thereof. To one of skill in this art who has the benefits of this

invention's realizations, teachings, disclosures, and suggestions, other purposes and advantages will be appreciated from the following description of preferred embodiments, given for the purpose of disclosure, when taken in conjunction with the accompanying drawings. The detail in these descriptions is not intended to thwart this patent's object to claim this invention no matter how others may later disguise it by variations in form or additions of further improvements.

10 Description Of The Drawings

27. A more particular description of certain embodiments of the invention may be had by references to the embodiments which are shown in the drawings which form a part of this specification.

15 28. Fig. 1A is a top view of a screen assembly according to
the present invention with a screen support according to the
present invention. Fig. 1B is a side view of the screen assembly
of Fig. 1A.

29. Figs. 2A and 3A are side views in cross-section of
20 fasteners system for use in releasably connecting a screen assembly
according to the present invention to a shale shaker. Fig 2B shows
the fastener of Fig. 2A in position connecting a screen assembly to
a shale shaker. Fig 3B shows the fastener of Fig. 3A in position
following activation connecting a screen assembly to a shale
25 shaker.

30. Fig. 4 is a side view in cross-section of a fastener system releasably connecting a screen assembly according to the present invention to a shale shaker.

31. Fig. 5 is a perspective view of and Fig. 6 is a schematic
30 view of a prior art shale shaker.

32. Figs. 7 - 9 are perspective views of shale shakers according to the present invention.

Fig. 10A is a schematic view of a system according to the

present invention. Fig. 10B shows a shale shaker of the system of Fig. 10A.

34. Figs. 11, 12, 13 and 15 are top views of screen assemblies according to the present invention.

5 35. Fig. 14A is a top view of a plastic grid according to the present invention.

36. Fig. 14B is a perspective view of a plastic grid according to the present invention.

10 37. Fig. 16 is a cross-sectional view of a screen assembly according to the present invention.

38. Fig. 17 is a perspective view of a frame support for a screen assembly according to the present invention.

15 39. Fig. 18A is a top view of a screen assembly according to the present invention. Fig. 18B is a bottom view of the screen assembly of Fig. 18A. Fig. 18C is an end view of one end of the screen assembly of Fig. 18A (and the opposing end is identical to that of Fig. 18C). Fig. 18D is a side view of one side of the screen assembly of Fig. 18A (and the opposing side is identical to that of Fig. 18C). Fig. 18E is a partial bottom perspective view 20 of the screen assembly of 18A. Fig. 18F is a partial bottom view of the screen assembly of Fig. 18A.

40. Fig. 19 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

25 41. Fig. 20A is a top view of a screen assembly according to the present invention. Fig. 20B is an end view, Fig. 20C is a side view and Fig. 20D is a bottom view of the screen assembly of Fig. 20A. Fig. 20E is a top view of possible hole shapes according to the present invention for the screen assembly of Fig. 20A.

30 42. Fig. 21 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

43. Fig. 22 is a perspective view of a screen assembly

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mounting structure for a shale shaker according to the present invention.

44. Fig. 23A is a top view of a screen assembly according to the present invention. Fig. 23B is an end view, Fig. 23C is a side view and Fig. 23D is a bottom view of the screen assembly of Fig. 23A.

45. Fig. 24 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

10 46. Figs. 25A - F and 25H are side schematic views of shale shakers according to the present invention. Fig. 25G is a side view of a screen assembly for the shale shaker of Fig. 25H.

47. Fig. 26 is a perspective view of a shale shaker according to the present invention.

15 48. Fig. 27 is a perspective view of a shale shaker according to the present invention.

49. Fig. 28 is a top view of a wear strip according to the present invention.

50. Fig. 29A is a top view of a wear strip according to the 20 present invention. Fig. 29B is a side view of the wear strip of Fig. 29A.

51. Fig. 30A is a top view of a wear strip according to the present invention. Fig. 30B is a side view of the wear strip of Fig. 30A.

25 52. Fig. 31A is a top view of a wear strip according to the present invention. Fig. 31B is a side view of the wear strip of Fig. 31A.

53. Fig. 32A is a top view of a wear strip according to the present invention. Fig. 32B is a side view of the wear strip of 30 Fig. 32A. Fig. 32C is a side view of an alternative embodiment of the wear strip of Fig. 32A. Figs. 32D and 32E are top views of wear strips according to the present invention.

54. Fig. 33 is a perspective view of a screen assembly

mounting structure for a shale shaker according to the present invention.

55. Fig. 34A is a top view of a wear strip according to the present invention. Fig. 34B is a side view of the wear strip of Fig. 34A.

56. Fig. 35A is a top view of a wear strip according to the present invention. Fig. 35B is a side view of the wear strip of Fig. 35A.

57. Fig. 36A is a top view of a wear strip according to the present invention. Fig. 36B is a side view of the wear strip of Fig. 36A.

58. Fig. 37A is a top view of a wear strip according to the present invention. Fig. 37B is a side view of the wear strip of Fig. 37A.

59. Fig. 38A is a top view of a wear strip according to the present invention. Fig. 38B is a side view of the wear strip of Fig. 38A.

60. Fig. 39A is a top view of a wear strip according to the present invention. Fig. 39B is a side view of the wear strip of Fig. 39A.

61. Fig. 40A is a top view of a wear strip according to the present invention. Fig. 40B is a side view of the wear strip of Fig. 40A.

62. Fig. 41A is a top view of a wear strip according to the present invention. Fig. 41B is a side view of the wear strip of Fig. 41A.

63. Fig. 42 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

64. Fig. 43 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

65. Fig. 44 is a bottom view of a wear strip of Fig. 43.

66. Fig. 45 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

5 67. Fig. 46 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

68. Fig. 47 is a perspective view of a screen assembly mounting structure for a shale shaker according to the present invention.

10 69. Fig. 48 is a bottom view of a screen assembly according to the present invention.

70. Fig. 49A is a perspective view of the upstanding member for embodiments of the present invention. Fig. 49B is a perspective view of the hole for embodiments of the present invention.

15 71. Fig. 50A is a top view of a screen assembly according to the present invention. Fig. 50B is a side cross-section view of the screen assembly of Fig. 50A.

72. Fig. 50C is a top view of a screen assembly according to 20 the present invention. Fig. 50D is a side cross-section view of the screen assembly of Fig. 50C.

73. Fig. 50E is a top view of a screen assembly according to the present invention.

25 74. Fig. 50F is a side cross-section view of the screen assembly of Fig. 50E.

75. Fig. 50G is a top view of a screen assembly according to the present invention.

76. Fig. 51 is a side view of a wear strip according to the present invention.

30 77. Fig. 52A is a perspective view of a vibratory separator according to the present invention. Fig. 52B is a perspective view of a screen assembly according to the present invention for use on

a vibratory separator as in Fig. 52A. Fig. 52C is a perspective view that shows the screen assembly of Fig. 52B mounted to the vibratory separator of Fig. 52A. Fig. 52D is a side view of a bar with pistons of the vibratory separator of Fig. 52A. Fig. 52E is a top view of a rail of the vibratory separator of Fig. 52A. Fig. 52F is an end view of the bar of Fig. 52D. Fig. 52G is a cross-sectional view of the rail of Fig. 52E. Figs. 52H and I are cross-sectional views showing connection of a piston of the vibratory separator of Fig. 52A to a rail.

10 78. Fig. 53A is a front view of a clamping system according to the present invention in a basket of a shale shaker according to the present invention. Fig. 53B is a partial view of part of the shaker of Fig. 53A. Fig. 53C is an enlarged view of part of the shaker of Fig. 53A.

15 79. Fig. 54 is an end cross-section view of a screen assembly clamping apparatus according to the present invention.

20 80. Fig. 55A is a front view of a clamping system according to the present invention in a basket of a shale shaker according to the present invention. Fig. 55B is an enlargement of part of the system of Fig. 55A. Fig. 55C shows bladders of the system of Fig. 55A holding a screen assembly in position.

81. Fig. 56 is a side view of a shale shaker according to the present invention.

25 82. Fig. 57 is a side view of part of a clamping apparatus according to the present invention.

DESCRIPTION OF EMBODIMENTS PREFERRED
AT THE TIME OF FILING FOR THIS PATENT

30 83. Figs. 52A - 52I show a vibratory separator 810 (or parts thereof) according to the present invention which has a support (812 shown schematically) and vibration apparatus 814 (shown schematically). The support 812 supports a basket 816 which has a

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deck 818 for supporting a screen assembly, e.g. like the screen assembly 830, Fig. 52B. The deck 818 has a series of holes 817 between crossmembers 815 and crossmembers 819a, 819b. The crossmembers 815 and 819b have upper curved surfaces to which a screen assembly installed thereon conforms.

84. Two bars 811 are secured to side walls 821 of the basket 816. Each bar 811 has three pistons 822 movably mounted therein. Fluid under pressure, in one aspect hydraulic fluid from an hydraulic fluid source 823 (shown schematically, Fig. 52D - dotted lines indicate fluid communication with channels in the bars 811) flows selectively into channels 824, 825 in the bars 811 to move the pistons 822 up and down.

85. The pistons 822 are releasably connected to movable rails 826 that move up and down as the pistons 822 move up and down. Fig. 52E shows a top view of a rail 826 with holes 826a for the pistons 822, with optional recesses 826b, and holes 826c for receiving pins (like the pins 854, 865 described below).

86. Figs. 52H and 52I show one method for releasably connecting a piston end 822a to a rail 826. A snap-ring (e.g. a plastic o-ring) 822b is positioned in a recess 826d of a hole 826a of the rail 826. Upon entry of the piston end 822a into a hole 826a of the rail 826, after forcing the piston end downwardly, a portion of the snap-ring 822b moves into a corresponding recess 822c of the piston end 822a, releasably connecting the piston end 822a to the rail 826. With an appropriate upward force, the piston 822 can be released from the snap-ring 822b and the piston removed from the rail 826. Three o-rings encircle the pistons 822, o-rings 822x, 822y and 822z. Prior to piston movement fluid under pressure introduced through a port 822r moves the piston 822 (and, therefore, its corresponding rail) downwardly. With the piston 822 in a down position (e.g. as in Fig. 52H) fluid introduced through a port 822s moves the piston (and, therefore the corresponding rail) upwardly.

87. Fig. 52B shows the screen assembly 830 which has screening material 831 and edges 832 each with a plurality of spaced-apart holes 833 whose location corresponds to pins as described below. Optionally a metal perforated plate or sheet is used beneath the screening material as part of the screening material, e.g. made of 14 gauge steel, with holes corresponding to the holes 833 that extend through the screening material. Optionally, instead of an entire perforated sheet or plate strips of metal are located beneath and/or above and along the edges 832 and the holes extend through these strips. As shown the screen assembly, in one aspect, is substantially flat (uncrowned) prior to installation on a separator like a shale shaker or the separator 810, Fig. 52A. The screen material 831 may be any known screening material useful on screen assemblies for vibratory separators or shale shakers, e.g. but not limited to, as any disclosed in any patent or application referred to herein and, in one particular aspect is three layers of stainless steel wire mesh including a first top layer of fine mesh, a second middle layer of fine mesh, and a third bottom layer of coarse mesh, with the holes 833 extending through all three mesh layers. Optionally, as desired, a support structure may be used under the third bottom mesh layer (e.g., but not limited to, strip support, frame, or plate).

88. As shown in Fig. 52C with the screen assembly 820 on the vibratory separator 810 and the rails 826 pushed down against it, the screen assembly 830 assumes a curved shape corresponding to the curve of the crossmembers 815 and 819a; the rails seal against screening material 831; and the screening material 831 is tensioned.

89. Figs. 53A - 53C illustrate a screen assembly clamping system 840 according to the present invention useful in vibratory separators and shale shakers, and, in one aspect, in a vibratory separator 810, Fig. 52A. Like numerals in Figs. 53A - 53C and in Figs. 52A - 52I indicate the same parts. Basket walls 816a of a basket 816 have bars 811 secured thereto with bolts 811a and

pistons 822 project down from the bars 811 into rails 826. Three pistons are used on each side, but in Fig. 53A only one piston on each side is shown. It is within the scope of this invention to use one, two, three, four or more such pistons on each of two sides 5 of a screen assembly. Optionally, side ledges 852 have upwardly projecting pins 854 that extend through corresponding holes 833 in edge portions 832 of the screen assembly 830 and into corresponding holes 842 of the rails 826 positioned above the screen assembly 830. The holes 842 are sufficiently long to allow the rails (or 10 bladder apparatus as described below) to hold the screen assembly down against the side supports and, in one aspect, to tension screening material on the screen assembly. It is within the scope of the present invention to provide such ledges 852 and pins 854 for any shale shaker or vibratory separator. In one aspect, 15 material to be treated by the shale shaker, (e.g. drilling fluid containing drilled cuttings, debris, etc.) is introduced onto the top of the screen assembly 830. Drilling fluids pass through screening material 831 and solid material and particles are moved off the top of the screen assembly 830 by vibratory action. It is 20 within the scope of this invention for any system herein to use one, two, three, four, five or more pins.

90. Each ledge 852 has a non-horizontal inwardly inclined angled upper surface 856 and each rail 826 has a correspondingly angled lowered surface 857. When an initially flat screen assembly 25 830 (see Fig. 52B) is positioned in place on the ledges 852, its outer edge portions 832 contact the upper surfaces 856 of the ledges 85. When the rails 826 are forced down onto the screen assembly 830, they bend the edges 833 into contacting conformity with the upper surfaces 856, with the tops of pins 854 moving into 30 corresponding holes 842, thereby crowning the screen assembly 830 and tensioning the screening material therein. The rails 826 forced down on the spaced-apart sides of the screen assembly effect a seal between the screen assembly and the ledges 852 and between

the screen assembly and the rails 826. It is within the scope of this invention for the pins 854 (and any pins disclosed herein) to be vertical or parallel with sides of a basket or screen support in which and/or on which a screen assembly is mounted or installed.

5 As shown in Fig. 53A, in Fig. 54 and Fig. 55A, it is within the scope of this invention to cant a pin or pins inwardly from the side or wall of a basket, etc. so that, as a screen assembly is forced down around the pin(s) (e.g. by movable rails or by inflating bladder apparatus), the screen assembly's screening material is tensioned. Such downward movement of rails or bladders 10 also effects seals along the sides of the screen assembly.

91. Fig. 54 shows another embodiment of a clamping system 860 according to the present invention which is similar to the system 840 (Fig. 53A) and like numerals indicate like parts; but the 15 system 860 does not have the ledges 852 with the angled upper surfaces 856. Side supports 863 support the screen assembly 830 and the downward force of the rails 826 bends the edge portions 832 of the screen assembly 830 against an upper surface 867 of the side supports 863. Optionally pins 864, like the pins 854, Fig. 53A 20 connected to crossmembers 815 extend into corresponding holes 865 in the rails 826. These pins 864 also extend through the holes 833 of the screen assembly 830.

92. Figs. 55A - 55C show a screen assembly clamping system 870 according to the present invention for a vibratory separator or shale shaker. Side ledges 872 (like the ledges 852, Fig. 53A) have upwardly projecting pins 874 that extend through corresponding holes in edge portions of a screen assembly 830. Each ledge 872 has a non-horizontal angled upper surface 876. Bladders 882 of bladder apparatuses 880 [bladders shown both uninflated (flattened, 30 882a) and inflated (oval, 882b) in Figs. 55A and 55b] press down on screening material of the screen assembly 830 and bend the edge portions into conformity with the angle of the upper surfaces 876 of the ledges 872, thus "crowning" the screen assembly 830 (as do

the piston mechanisms and rails 40 in the system of Figs. 52C and 53A) and tensioning the screening material.

93. As shown in Fig. 55B air from a pressurized air source PS provides air under pressure for inflating the bladders 882.

5 94. As shown in Fig. 55C, the screen assembly 830 may, optionally, have side lips or hooks 830c which are selectively releasably positionable in gaps 830d between brackets 882a holding the bladders 882 and side walls 882b of a vibratory separator. Any known shape or configuration for any known hookstrip and/or hooks 10 may be used with associated well-known hook or hookstrip holding apparatus.

95. Fig. 55C shows a system 870a like the system 870, Fig. 55A, and like numerals indicate like parts; but the system 870a does not have the ledges 872. Side supports 877 support the screen 15 assembly 830 and the downward force of the bladders 882 bends the edge portions 832 of the screen assembly 830 against an upper surface 878 of the side supports 877.

96. Fig. 56 shows a shale shaker 890 according to the present invention which has a screen mounting basket 891; vibration 20 apparatus 892 connected to the basket 891; a mounting skid 893 spring mounts 894 (two on each side) connecting the basket 891 to the skid 893; and a lower receptacle 895 which receives fluid passing through screen assemblies 896a and 896b.

97. Piston mechanisms 897 (like the piston mechanisms 25 described above) releasably hold the screen assemblies 896a and 896b in place.

98. Fluid is introduced onto the screen assembly 896a from a tank or "possum belly" 898. Separated solids progress up the screen 896a and are discharged onto the screen assembly 896b. 30 Following further fluid separation, the solids move up and off of the screen assembly 896b and are discharged from the shale shaker 890. Hydraulic fluid to power the piston mechanisms is provided in lines 899a, 899b, 899c, and 899f from a pressurized source 899d.

99. Fig. 57 shows a manually operable apparatus 895 for moving rails 826. Members 896 with handles 897 and cam surfaces 898 are movable on shafts 899 to move a rail 826 downwardly. The rails 826 in this aspect are movably mounted to corresponding basket side walls or other structure.

100. Figs. 1A and 1B show a screen assembly 10 according to the present invention which has a perforated plate 11 on which is mounted three layers 12 of mesh or screening material. One, two, four, or more layers of screening material may be used. The plate 11 has a plurality of side holes 18 on each of two of its sides for receiving releasable fasteners for mounting the screen 10 in a suitable shale shaker. Optionally, the screen assembly's plate 11 may also have inner portions 15 with holes 16 therethrough and/or inner portions 15a with interior holes 16a therethrough which holes are also for receiving releasable fasteners for releasably connecting the screen assembly to the shale shaker. To insert the fasteners through the holes 16, 16a and 18 into holes in a deck or bed below a screen assembly, corresponding and appropriate holes or openings are made in the screening material. Although the entire inner portions 15a are revealed in Fig. 1A, in an actual screen assembly, prior to making holes in screening material, the holes 16a and inner portions 15a are covered by screening material.

101. Fig. 2A shows a fastener system 20 according to the present invention which has a top member 21 with a lower portion 22 that is received within a bottom member 23 which has a plurality of spaced-apart fingers 24. The lower portion 22 upon insertion into the bottom member 23 forces the fingers 24 apart for a tight friction fit of the lower portion 22 within the bottom member 23. An upper shoulder 25 of the bottom member 23 abuts the top surface 30 of a screen assembly SC which may be any screen assembly according

to the present invention. A shale shaker deck 26 has a hole 27 corresponding to a hole 27a through the screen assembly SC through

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which is mounted the bottom member 23. Any fastener hole in any screen assembly or part thereof according to the present invention and/or any corresponding hole through a shaker deck according to the present invention may have any desired opening shape as viewed from above, including, but not limited to, rectangular, triangular, elliptical, oval, pentagonal, circular, and hexagonal.

102. Fig. 2B shows the fastener system 20 releasably holding the screen assembly SC to the shaker deck 26. Spaced apart shoulders 28 and 29 of the top member 21 provide an abutment against the screen assembly SC (the bottom shoulder 28) and a structure (the top shoulder 29) to grasp or contact to facilitate removal of the fastener.

103. Figs. 3A and 3B show another embodiment of a fastener system according to the present invention for releasably connecting a screen assembly to a shale shaker. A system 30 has a fastener 31 with a body 32 and a lower inflatable member 33. A stop shoulder 39 on the body 32 abuts the top of a screen assembly SC (like that of Fig. 2A). Following insertion of the body 32 through a hole 34 in the screen assembly SC (see Fig. 3A), the inflatable member 33 is inflated through valve apparatus 35 to hold the fastener (and thus the screen assembly) in place. To release the fastener, the valve apparatus is activated to allow air to escape from the inflated inflatable member 33. The inflatable member 33 is sized and positioned so that, upon inflation, it abuts an underside of the deck 36 (like the deck 26, Fig. 2A) of a shale shaker.

104. Fig. 4 shows a fastener 40 for releasably connecting a screen assembly SC (like that of Fig. 2A) to a shale shaker with a deck 46 (like the deck 26, Fig. 2A). The fastener 40 has a body 41 that is inserted through a hole 42 in the screen assembly SC. Optional threads 43 on the fastener body 41 mate with corresponding threads 44 on the deck 46 to releasably hold the fastener, and thus the screen assembly, in place. Any fastener according to the present invention and any deck according to the present invention

may have such threads. Optionally, the threads are deleted and the fastener is held in place with a friction fit; and/or, glue, epoxy, or an adhesive is used to hold the fastener in position (as may be done, optionally, with any other fastener disclosed herein); or a non-threaded locking fastener is used with required holes and/or surfaces on the shaker deck or bed. Any suitable screw or bolt may be used for the body 41. Optionally, the fastener 40 has a top head 45 that facilitates turning of and removal of the fastener 40. Any fastener in Figs. 2A - 4 may be used with any screen assembly disclosed herein.

105. It is within the scope of this invention for the screen assembly SC to have one, two, three or more layers of screening material, i.e., screen, mesh, and/or cloth made, e.g., of stainless steel wire and/or plastic. Any such layer or combination of layers may be bonded together (glued, welded, and/or sintered) in any known manner and/or bonded to the plate 11 in any known manner. Any such layer or layers of screening material may be substantially flat or may be undulating (with a series of alternating ridges and valleys) as is well known in the art. According to the present invention any known support, plate, strip support, or frame for supporting a shale shaker screen and/or for mounting thereto of one or more layers of screening material, mesh, and/or cloth may have one or more holes for receiving one or more fasteners according to the present invention for releasably connecting a screen assembly to a shale shaker.

106. Fig. 7 shows a shale shaker 70 according to the present invention which is like a shaker disclosed in U.S. Patent 5,641,070 co-owned with the present invention and incorporated fully herein for all purposes; but the shaker 70 has a basket 71 with screen mounting decks 72 and 73. Supports 72a and 73a of the decks 72 and 73, respectively, have holes 72b, 72c, 72d and 72e therethrough (in deck 72) and 73a, 73b, 73c (in deck 73). As desired such holes may be provided on all sides and/or on all cross-members of either or

both decks. These holes are sized and positioned to correspond to holes in a screen support (and, optionally, holes through screening mesh and/or cloth) of screen assemblies (not shown) to be mounted in the basket 71. Springs 75 (two shown; four, six or more may be used) support the basket in a shaker body 76 and one or more vibrators 77 connected to the basket 71 vibrate the basket 71. Holes as in either or both decks 72, 73 may be provided for the deck(s) of any known multi-deck shale shaker so that screen assemblies according to the present invention with holes according to the present invention may be releasably fastened thereto.

107. Fig. 8 shows a shale shaker 80 according to the present invention with screen assemblies 81, 82 according to the present invention mounted in a basket 83 to decks 86, 87 with fasteners 84, 85 which may be any screen assembly disclosed herein according to the present invention. The fasteners 84, 85 extend through holes (not shown) in the screen assemblies into holes (not shown) in the decks 86, 87. The basket 83 is mounted on spring mounts 88 (three shown; four used in this embodiment) and is vibrated by a vibrator 89.

20 108. Referring now to Fig. 9, a shale shaker 90 according to the present invention has a screen deck 92 according to the present invention in a basket 91. The deck 92 has holes 93 therearound into which are releasably inserted fasteners (not shown; including, but not limited to, fasteners as disclosed herein and/or fasteners according to the present invention) to releasably secure one or more screen assemblies (not shown) to the deck 92. Any screen according to the present invention may be used on the deck 92. The basket 91 is mounted on springs 94 (only two shown; two as shown are on the opposite side) which are supported from a frame 96. The basket 91 is vibrated by a motor 99 and interconnected vibrating apparatus 98 which is mounted on the basket 91 for vibrating the basket and the screens. Optional elevator apparatus 97 provides for raising and lowering of the basket end.

109. Referring now to Figs. 10A and 10B a well 111 is being drilled by a bit 112 carried on a string of drill pip 114. Drilling mud is pumped by a pump 118 into the drill pipe 114 and out through nozzles in the bit 112. The mud cools and cleans the cutters of the bit and then passes up through a well annulus 116 flushing cuttings out with it.

110. After the mud is removed from the well annulus 116, it is treated before being pumped back into the pipe 114. First, the mud enters the shale shaker 110 where relatively large cuttings are removed. The mud then enters a degasser 124 where gas can be removed if necessary. Degasser 124 may be automatically turned on and off, as needed, in response to an electric or other suitable signal produced by a computer 124 and communicated to degasser 124 as indicated by line 125. The computer 134 produces the signal as a function of data from a sensor assembly 136 associated with shale shaker 110 and described more fully below. The data from sensor assembly 136 is communicated to computer 134 by line 182. The mud then passes to a desander and (or a desilter), jointly represented by station 126, for removal of smaller solids picked up in the well.

111. The mud next passes to a treating station 128 where, if necessary, conditioning media, such as barite, may be added from source 130. As shown, suitable flow control means, indicated in a simplified form by valve 132, controls flow of media from source 130 to station 128. Valve 132, in turn, may be automatically operated by an electric or other suitable signal produced by computer 134 as a function of the data from sensor assembly 136, such signal being communicated to valve 132 as indicated by line 131.

112. From the station 128, the mud is directed to tank 140, from which pump 118 takes suction, to be re-cycled through the well. Any shale shaker disclosed herein may be substituted for the shale shaker 110. The system 100 is like the systems disclosed in

U.S. Patent 5,190,645 (incorporated fully herein for all purposes), but the system 100 has a shale shaker according to the present invention.

113. The shale shaker 110 as shown in detail in Fig. 10B has
5 a basket 121 in which a screen mounting deck 122 (shown
schematically in Fig. 10B). A screen assembly 123 according to the
present invention (shown schematically) is releasably secured to
the deck 122 by a plurality of spaced-apart fasteners 133 which
extend through holes 135 in the screen assembly 123 and through
10 corresponding holes 137 in the deck 122. Vibrator apparatus 139
vibrates the basket 121 which is mounted on mounts 127. Material
flows through exit structure 141 into a collection receptacle 143.

114. The screen assembly 123 may be any (one, two, three or
more) screen assembly according to the present invention and the
15 fasteners 133 may be any fastener according to the present
invention.

115. Fig. 11 shows a screen assembly 190 according to the
present invention which has a lower tubular frame support 191 to
which is connected and/or welded a perforated plate 192 (including,
20 but not limited to a perforated plate like that disclosed in U.S.
Patent 4,575,421, incorporated fully herein for all purposes; but
with holes according to the present invention for receiving
fasteners according to the present invention to releasably connect
the screen assembly 190 to a shale shaker).

116. The perforated plate 191 of the screen assembly 190 has
25 a plurality of peripheral holes 193 and a plurality of interior
holes 194 (either holes 193 or holes 194 may be deleted — as is the
case for any support, plate, or frame according to the present
invention). A plurality of fasteners 195 (two shown; one through
each hole 193, 194) connect the plate 192 to the tubular frame
support 191. The fasteners' lower ends are received in holes 196
of the tubular frame support 191 whose position corresponds to that

of the holes 193, 194.

117. As shown in Fig. 11 there are three layers 197a, 197b, 197c of screening material on the plate 192. Any one or two of these layers may be deleted; any known combination of layers may be used; and the layers may or may not be connected and/or bonded together at their edges and/or across their surfaces in any known manner with any known material and/or process. Any known suitable tubular members may be used to make the tubular frame support 191 with its outer members 191a and its cross-members 191b.

118. Fig. 12 shows a screen assembly 210 according to the present invention with a unibody structure 220 according to the present invention. The screen assembly 210 has, optionally, three 211, 212, 213 of screening material (shown partially; extending over the entire open area of the unibody structure 220) bonded to a top surface 222 of the unibody structure 220. Preferably, the layers 211, 212, 213 are also bonded together over substantially their entire surface area. A plurality of fasteners 240 extend through holes 241 in the unibody structure 220 to releasably connect the screen assembly 210 to a screen mounting deck 242 of a shale shaker (not shown in its entirety). Optionally, one or more fasteners 243 (one shown) may extend through the layers of screening material on the screen assembly 210 and into the deck 242.

119. A plurality of openings 224 through the unibody structure 220 define a plurality of support members 226. To the underside of the unibody structure 220 are, optionally, connected a plurality of spaced-apart ribs 228 which, in one aspect are welded to a metal unibody structure 220. In this particular embodiment the ribs 228 are positioned along a substantial majority of their length directly beneath one of the support members 226 that extend across a major portion of the unibody structure 220; but it is within the scope of this invention to use no such ribs or to position them anywhere on the underside of the unibody structure 220. The

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unibody structure 220 has spaced-apart sides 236, 238. The screen assembly 210 has an end 214 and a ledge end 216. The ledge end has an upper ledge portion that rests on a shoulder of an end of an adjacent screen. Thus one screen end seals against another screen end when such screens are used end-to-end (as described in U.S. Patent 6,283, 302 co-owned with the present invention as incorporated fully here for all purposes).

120. Fig. 13 shows a screen strip support 250, according to the present invention with a plurality of spaced-apart strips 252 (made of any suitable metal or metal-like material) secured to and between spaced-apart sides 254. The screen strip support 250 is like the strip support of Fig. 51A, U.S. Patent 6,290,068 (co-owned with the present invention and incorporated fully herein for all purposes); but the screen strip support 250 has outer holes 267 and inner holes 268 through which may be inserted any fastener disclosed herein for releasably connecting the support 250 (and any screen assembly of which it is a part) to a shale shaker deck. Either holes 267 or holes 268 may be deleted. Any known strip support may be provided, according to the present invention, with holes 267 and/or holes 268. Each end 256 of each strip 252 is received and held in a recess 264 in a side 254. The recess 264 corresponds in shape to the shape of the end 256 and a shoulder 266 of each strip 252 abuts a side 254. The end 256 may be inserted into the recess 254 from the side or from above or below. The top and bottom strips 252 each has two humps or ridges 253 which are located, sized, and configured to be received in corresponding corrugations of a corrugated plate and/or corrugated screen assembly. It is within the scope of this invention for each strip to have one, two, or a plurality of multiple humps or ridges. In one aspect there is one hump or ridge for each corrugation on a superimposed plate and/or screen assembly. It is within the scope of this invention to delete the humps and/or ridges so that the strips 252 are flat for use with flat mesh and/or screen(s).

121. Figs. 14A and 14B show plastic grids 270, 271, respectively, each with a body 270d, 271d respectively with a plurality of openings 270a, 270b, 271b respectively, therethrough. Although only certain of the openings 271b are shown, it is to be
5 understood they extend across the entire surface of the body 271d. The plastic grids 270, 271 are like plastic grids disclosed in U.S. Patents 5,417,859; 5,958,236; 5,783,077; and 6,053,332 (all these patents incorporated fully herein for all purposes); but the grids 270, 271 each have a plurality of spaced-apart holes 270c, 271c,
10 respectively therethrough for accommodating fasteners according to the present invention which extend through a screen assembly according to the present invention to releasably connect a screen assembly to a shale shaker. Any grid disclosed in the patents cited above and any known plastic grid or piece used in a screen assembly for a shale shaker may have holes as shown in Figs. 14A and 14B (and/or any holes disclosed herein for any perforated plate or support disclosed herein); and any screen or screen assembly disclosed in the patents cited above may have any such grid or piece. Any such grid or piece according to the present invention
15 may have holes corresponding to any fastener holes as described herein. In one aspect the holes in the grid or piece are made, according to the present invention, prior to the final formation or assembly of a screen or screen assembly (as may also be the case with any perforated plate or strip support according to the present invention); while in another aspect the holes are made through the plastic grid (and/or through other parts, pieces and/or layers of the screen or screen assembly) following final formation or assembly thereof (as may also be the case with any perforated plate, frame or strip support according to the present invention).
20 It is to be understood that it is within the scope of the present invention to have a plastic layer or a mass of fusing plastic fusing together layers of screening material, the layer or mass optionally provided initially by a plastic grid, the plastic layer
25

or mass having holes for fasteners corresponding to holes in a screening material support.

122. Fig. 15 shows a screen assembly 280 according to the present invention with a lower supporting perforated plate 281 according to the present invention. The screen assembly 280 is like those disclosed, e.g., in U.S. Patent 4,575,421 (incorporated fully herein for all purposes; but without hookstrip mounting apparatus and with a plurality of peripheral holes 282 and one or more interior holes 284 for receiving fasteners 283 to releasably connect the screen assembly 280 to a shale shaker (not shown) whose deck or mounting structure has corresponding holes for releasably receiving a portion of the fasteners 283 (as is the case for a shale shaker and fasteners through any screen or screen assembly according to the present invention). In certain preferred aspects holes 282 and/or 284 are simply added to a perforated plate as shown in U.S. Patent 4,575,421; while in other aspects the plate is initially made so that plate portions 288 have only a hole 282 or a hole 284. In one particular aspect (as is true for any perforated plate according to the present invention) an area like the areas 288 (and/or like the areas 15, Fig. 1A and/or like the areas around the holes 193, 194, Fig. 11 and for any plastic grid or piece according to the present invention) are at least as large (viewed from above) as one of the openings or perforations through the plate and in another preferred aspect are at least twice as large (viewed from above) as such an opening or perforation.

123. One, two, or three (or more) layers of mesh and/or screening material may, according to the present invention, be used on a perforated plate 280 (or on any perforated plate according to the present invention); e.g., as shown in Fig. 15, three layers 285, 286, and 287 are used on the plate 281. Although these layers are shown partially, it is to be understood they substantially cover the plate 281.

124. The prior art discloses a variety of non-flat screens and

screen assemblies sometimes referred to as "3D" or "Three Dimensional" screens (e.g., but not limited to, as disclosed in U.S. Patents 5,417,793; 5,417,858; 5,417,859; 6,053,332; 5,598,236; 5,783,077; 6,283,302; 6,290,068 — all incorporated fully herein for all purposes). Fig. 16 illustrates that, according to the present invention, non-flat screen assemblies may be fastened with releasable fasteners passing through holes therethrough to a shale shaker. A screen assembly 290 (shown partially) has a lower perforated plate 291 (which, optionally, may be any support plate, frame, or strip support) with a plurality of spaced-apart openings 292 therethrough (see, e.g., but not limited to, Fig. 13, U.S. Patent 5,417,858; and Fig. 3, U.S. Patent 5,417,859 regarding possible plates and screening material). A plurality of fasteners 295 passing through holes 296 (in screening material 294), holes 297 (in the plate 291) and into (and, optionally, through) holes 298 (in a shaker deck 293).

125. As shown in Fig. 16, it is also within the scope of this invention to employ one or more fasteners 299 which extend through a portion of the screening material 294 that is not directly adjacent the plate 291 but which is spaced-apart therefrom. As shown a fastener 299 passes through a highest (with respect to the plate 291 as viewed in Fig. 16) portion of the screening material 294 and through holes 299a, and 299b, in the plate 291 and deck 293, respectively, and through a hole 299c in the material 294; but it is within the scope of this invention to have one or more fasteners 299 (or 295) pass through any part or portion of the screening material 294. As may be the case with any fastener according to the present invention and any fastener used with a screen assembly according to the present invention, any suitable desired washer(s) and/or sleeve(s) may be used with the fastener(s) 295, 299 at any interface and/or for any hole.

126. It is within the scope of the present invention to

provide holes for fasteners as disclosed herein in any known prior art frame used as a support for screening material for a screen assembly for a shale shaker. Fig. 17 illustrates a frame 300 according to the present invention which is like a frame as disclosed in U.S. Patent 5,417,858, Fig. 8; but which has a series of outer holes 301 through tubular frame members 302 and, optionally, (or instead of the holes 301) holes 303 through interior tubular members 304. Any holes described herein for releasably fastening a screen assembly to a shale shaker may be used in the frame 300 or in any frame support for a shale shaker screen assembly. Any layer or layers of mesh or screening material described or referred to herein or known in the prior art may be used on the frame 300 or on any frame according to the present invention.

127. With screen assemblies according to the present invention (e.g. as in Fig. 1A) which employ no lower support frame, any opening through the lower support can receive a common plug to replace torn screening material above the opening and no frame member blocks any of the openings which could require a customized plug.

128. Figs. 18A - 18F show a screen assembly 340 according to the present invention which has a tubular frame 342 with ends 344 and interconnected sides 345. A screening material combination 350 is secured with cured epoxy to the tubular frame 342. A crossmember 341 (of a plurality of spaced-apart crossmembers 343 that extend between and have ends connected to the sides 345) has two notches 346, either of which is for receiving a portion of an upstanding member of a shale shaker deck.

129. In certain shale shakers in which screen assemblies without crossmembers such as the crossmember 341 are used, one or more upstanding members are located so that they do not push up on a screen assembly above them and such upstanding members are often used for proper screen assembly positioning, for preventing

unwanted screen movement with respect to a shaker deck, or for stabilizing screen assemblies in position. Rather than removing such upstanding member(s) when a screen assembly is used that does have one or more crossmembers that would undesirably abut the top
5 of an upstanding member (preventing correct screen assembly emplacement on a deck), a screen assembly according to the present invention may be installed on such a shaker deck so that a portion of the upstanding member (which is perpendicular to the crossmember 41 as viewed from above or below) is received in and projects into
10 one (or more) of the notches 346. With a screen assembly 340 as shown, the crossmembers 343 on either side of the crossmember 341 are sufficiently spaced-apart from the crossmember 341 that the upstanding member does not contact the adjacent crossmembers 343. Although only one notch 346 can accommodate an upstanding member,
15 by using two notches 346, proper emplacement of the screen assembly 340 over the upstanding member is made "fool proof" — i.e. whichever side of the screen assembly is placed nearest the shaker's exit end (or fluid introduction end) one of the notches will be above the upstanding member. Of course it is within the
20 scope of the present invention to place aligned notches on adjacent crossmembers to accommodate an upstanding member of such dimensions that it extends beyond the distance separating two, three, four or more crossmembers. The screen assembly 340 as shown has a multi-layer combination 350 of layers of screening material glued
25 together with moisture curing hot melt glue in a glue pattern 362. The multi-layer glued-together combination 360 is secured to the tubular frame 342 with cured epoxy.

130. Fig. 19 shows a mounting structure (or "tray") 400 for a shale shaker on which is releasably securable one or more screen
30 assemblies. As shown a screen assembly mounts on and covers tray 400, but it is within the scope of this invention to have a larger tray on which two, three or more screen assemblies are secured or

to have multiple trays 400 on a single shale shaker (as is true for any tray or mounting structure according to the present invention disclosed herein). Although a particular tray is shown in Fig. 19, it is to be understood that, according to the present invention,
5 the teachings of the various holes and projecting members for trays (e.g., as in Figs. 19-49) are applicable to known screen mounting structures for shale shakers in which and on which the holes and
and upstanding members may be used; and similarly for the screen
assemblies shown in Figs. 20A - 48 the various holes and projecting
10 members may be used with any suitable known screen assembly.

131. The tray 400 has two spaced-apart outer ends 402, 404 which are spaced-apart by sides 406. The entire tray 400 is positioned in and connected to a basket or other suitable enclosure or housing of a shale shaker. Crossmembers 408 extend from end to end of the tray 400 and crossmembers 410, 412 extend between crossmembers 408 and sides 406. A support member 409 extends beneath one of the crossmembers 408 (and such a support may be under any crossmember). Wear strips 414 are connected to tops of the sides 406 and wear strips 416 are on tops of some of the interior crossmembers. An upstanding member 420 projects upwardly from each end 402, 404 of the tray 400. Each upstanding member 420 is located, sized, and configured for receipt within a corresponding hole of a screen assembly placed on the tray 400. Fluid to be treated by a shale shaker with a tray as in Fig. 19 (or
20 any tray disclosed herein) may flow across a screen assembly placed on the tray in any desired direction; and one such direction is indicated by the arrows AA and BB in Fig. 19.

132. Figs. 20A - 20D show a screen assembly 430 according to the present invention which has a lower support frame 432 (which may be any known screen assembly support frame or which may, alternatively, be any known screen assembly support such as a strip support, perforated plate, or unibody structure). Screening material 434 (shown partially, but covering the frame 432) is on

the top of the frame 432 and may be any known screening material used in screen assemblies for shale shakers, including, but not limited to, multi-layer screen meshes and/or flat or 3-D materials. A lower bar 436 is connected to or formed integrally of the frame 432 at each of its ends. Each end of the screen assembly 430 has a hole 438 for receiving a member projecting upwardly from a shale shaker's screen mounting structure, e.g., but not limited to, like the upstanding members 420, Fig. 19. The holes 438 do not extend through the top of the frame 432.

10 133. Fig. 20E shows possible shapes 439a, b, c, d, e, f, g, h, i and j as viewed from above, for any upstanding member or upwardly projecting member according to the present invention, and also for holes corresponding to such upstanding or upwardly projecting members.

15 134. Fig. 21 shows a tray 440 according to the present invention which is like the tray 400 (and like parts are designated with the same numerals), Fig. 19; but which has three upstanding members 420 at each of its ends, each for receipt within corresponding holes of a screen assembly to be emplaced on the tray 20 400. Tray ends or sides according to the present invention may have any desired number of upstanding or upwardly projecting members for receipt within corresponding holes of a screen assembly.

25 135. Fig. 22 shows a tray 450 like the tray 400 (and like parts are designated with the same numerals); but without any upstanding members 420 and with a hole 452 in each of its ends. The holes 452 are located, sized, and configured for receiving corresponding downwardly projecting members of a screen assembly emplaced on the tray 450.

30 136. Figs. 23A - 23D show a screen assembly 460 according to the present invention like the screen assembly 430, Fig. 20A, and like numerals designate like parts. Instead of holes 438, however, the screen assembly 460 has downwardly projecting members 468 on

each of its ends. The downwardly projecting members 468 are located, sized, and configured for receipt within corresponding holes in a shale shaker's screen mounting structure, e.g., but not limited to, such as the holes 4552, Fig. 22.

5 137. Fig. 24 shows a tray 470 according to the present invention like the trays 400 (Fig. 19) and 450 (Fig. 22); but with two upstanding members 472 at each of its ends and a hole 474 in each of its ends. Each upstanding member 472 is located, sized and configured for receipt within a corresponding hole of a screen assembly and the hole 474 is located, sized and configured for receiving a corresponding downwardly projecting member of a screen assembly. Either one or both of the upstanding members 472 may be deleted; there may be three or more upstanding members 474; the hole 474 may be deleted; and/or there may be two, three or more holes 474 — as is true for any tray according to the present invention.

10 138. Figs. 25A - 25H show schematically shale shakers according to the present invention with shale shaker decks (screen mounting structures) according to the present invention. The shale shakers of Figs. 25A - 25H are like the shale shaker of Fig. 10B and like numerals designate the same parts. It is within the scope of the present invention to employ any of the holes or upstanding members in Figs. 25A - 25H on any shale shaker mounting structure disclosed herein. Also, any screen assembly disclosed herein can have the hole(s) and/or downwardly projecting members of the screen assembly of Fig. 25G. It is to be understood that although the drawings of Figs. 25A - 25H show upstanding members or holes at only one side of a deck, the other side (not shown) of the deck may have the same structure, or it may have none of the structure shown.

15 139. A shale shaker 480 shown in Fig. 25A has a plurality of spaced-apart holes 481, each hole for receiving a corresponding

downwardly projecting member of a screen assembly placed on the shale shaker's deck. The holes 481 extend down substantially perpendicularly into the deck 122. Any number of holes 481 may be used (one - four or more).

5 140. A shale shaker 482 shown in Fig. 25B has a plurality of spaced-apart holes 483, each hole for receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck. The holes 483 extend down at an angle (toward the left) into the deck 122. Any number of holes 483 may be used
10 (one - four or more) and they may extend into the deck 122 at any desired angle, including, but not limited to, angled toward or away from a fluid introduction end or fluid exit end.

15 141. A shale shaker 484 shown in Fig. 25C has a plurality of spaced-apart holes 485, each hole for receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck. The holes 485 extend down at an angle into the deck 122. Any number of holes 485 may be used (one - four or more) and they may be angled at any desired angle in any desired direction.

20 142. A shale shaker 486 shown in Fig. 25D has a plurality of spaced-apart upstanding members 487, each hole for receipt within a corresponding hole of a screen assembly placed on the shale shaker's deck. The upstanding members 487 extend up substantially perpendicularly to the deck 122. Any number of members 487 may be used (one - four or more).

25 143. A shale shaker 488 shown in Fig. 25E has a plurality of spaced-apart upstanding members 489, each for receipt within a corresponding hole of a screen assembly placed on the shale shaker's deck. The upstanding members 489 extend up at an angle to the deck 122. Any number of members 489 may be used (one - four or more) and they may project from the deck at any desired angle in any desired direction.

144. A shale shaker 489 shown in Fig. 25F has a plurality of

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spaced-apart upstanding members 491, each for receipt within a corresponding hole of a screen assembly placed on the shale shaker's deck. The upstanding members 491 extend up at an angle to the deck 122. Any number of upstanding members 491 may be used (one - four or more) and they may be at any desired angle in any desired direction.

145. A shale shaker 492 shown in Fig. 25H has a plurality of spaced-apart holes 493, each hole for receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck and a plurality of spaced-apart upstanding members 494 projecting up from the deck 122. The holes 493 extend down substantially perpendicularly into the deck 122 (but may be at any angle at any direction) and the upstanding members 494 project up substantially perpendicularly to the deck 122, but may be at any angle in any direction. Any number of holes and/or upstanding members may be used (one - four or more).

146. Fig. 25G shows schematically a screen assembly 495 according to the present invention, useful on a shale shaker, which has a body or support 496 with two spaced-apart downwardly projecting members 497 and two spaced-apart holes 498. The downwardly projecting members 497 are for receipt within corresponding holes (e.g. but not limited to, such as the holes 493, Fig. 25H) in a shale shaker screen assembly mounting structure; and the holes 498 are for receiving corresponding upwardly projecting members of a shale shaker mounting structure (e.g., but not limited to, such as the upstanding members 494, Fig. 25H).

147. Fig. 26 shows a shale shaker 500 like the shale shaker of Fig. 19 (like numerals indicate the same parts); but with a plurality of spaced-apart upwardly projecting members 502 projecting up from the deck 92. It is to be understood, although not shown, that as desired, upstanding members 502 may be provided spaced-apart on both sides or around the entire periphery of the

deck 92 (or of any shaker deck). Optionally, the holes 93 may be deleted or they may be sized for receiving downwardly projecting members of a screen assembly.

148. Fig. 27 shows a shale shaker 504 like that of Fig. 27 but with a plurality of spaced-apart upwardly projecting members 506 at the sides of the screen assembly mounting structures of the shale shaker. Optionally, the holes (or some of them) 72 and 73 may be deleted or they may be sized to receive a downwardly projecting member of a screen assembly.

149. Fig. 28 shows a wear strip 510 according to the present invention which has a body 511 and an upstanding member 512 for receipt within a corresponding hole of a screen assembly. Using openings 513 at either end of the body 511, the wear strip 510 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 513 has, optionally, a bevelled edge 514 for ease of installation, e.g., but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In certain aspects the openings 513 are located so that the wear strip 510 is slipped onto corresponding upstanding members of a shale shaker mounting structure (e.g. as in Fig. 33). The wear strip (and any wear strip herein) 510 may be made of any suitable material, e.g., but not limited to fiberglass, rubber, zinc, zinc alloy, urethane, BUNA-N, aluminum, aluminum alloy, steel, stainless steel, wood, iron or plastic as may be the upstanding member 512 (as may be any wear strip or mounting structure disclosed herein).

150. Fig. 29A and 29B show a wear strip 520 according to the present invention which has a body 521 and an upstanding member 522 for receipt within a corresponding hole of a screen assembly. Using openings 523 at either end of the body 521, the wear strip 520 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 523 has, optionally, a bevelled edge 524 for ease of installation, e.g., but

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not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In certain aspects the openings 523 are located so that the wear strip 520 is slipped onto corresponding upstanding members of a shale shaker mounting structure (e.g. as in Fig. 33). The wear strip (and any wear strip herein) 520 may be made of any suitable material, e.g., but not limited to fiberglass, rubber, steel, stainless steel, wood, iron or plastic as may be the upstanding member 522.

10 151. Fig. 30A and 30B show a wear strip 530 according to the present invention which has a body 531 and an upstanding member 532 for receipt within a corresponding hole of a screen assembly. Using openings 533 at either end of the body 531, the wear strip 530 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 533 has, optionally, a bevelled edge 534 for ease of installation, e.g., but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In certain aspects the openings 533 are located so that the wear strip 530 is slipped onto corresponding upstanding members of a shale shaker mounting structure (e.g. as in Fig. 33). The wear strip (and any wear strip herein) 530 may be made of any suitable material, e.g., but not limited to fiberglass, rubber, steel, stainless steel, wood, iron or plastic as may be the upstanding member 532. As with any of the wear strips in Figs. 28 - 32A, any desired number of upstanding members of any desired shape may be used. Also, any such upstanding member may be formed integrally of or connected to a wear strip according to the present invention.

25 152. Fig. 31A and 31B show a wear strip 540 according to the present invention which has a body 541 and an upstanding member 542 for receipt within a corresponding hole of a screen assembly. Using openings 543 at either end of the body 541, the wear strip 540 is connectible to an end or side or crossmember of a shale

shaker's screen assembly mounting structure. Each opening 543 has, optionally, a bevelled edge 544 for ease of installation, e.g., but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In 5 certain aspects the openings 543 are located so that the wear strip 540 is slipped onto corresponding upstanding members of a shale shaker mounting structure (e.g. as in Fig. 33). The wear strip (and any wear strip herein) 540 may be made of any suitable material, e.g., but not limited to fiberglass, rubber, steel, 10 stainless steel, wood, iron or plastic as may be the upstanding member 542.

153. Fig. 32A - 32C shows a wear strip 550 according to the present invention which has a body 551 and an upstanding member 552 (Fig. 32B) or 557 (Fig. 32C) for receipt within a corresponding hole of a screen assembly. Using openings 553 at either end of the body 551, the wear strip 550 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 553 has, optionally, a bevelled edge 554. Any upstanding member in any embodiment of the present invention may 20 have a rounded surface as does the upstanding member 557. Figs. 32D and 32E show wear strips with a hole at one end and an opening at the other end. Fig. 32D shows a wear strip 550a like the wear strip 550, Fig. 32A. The wear strip 550a has a body 551a, like the body 551 described above, with an opening 553a, like the opening 25 553 described above and with an upstanding member 557a, like the upstanding member 557 described above. The wear strip 550a also has a hole 573a, like the hole 573 described below. Fig. 32E shows a wear strip 550b like the wear strip 550, Fig. 32A. The wear strip 550b has a body 551b, like the body 551 described above, with an opening 613a, like the opening 613 described below and with an 30 upstanding member 557b, like the upstanding member 557 described above. The wear strip 550b also has a hole 573b, like the hole 573 described below. The wear strips of Figs. 32D and 32E are

emplaceable on a tray with their end hole receiving an upstanding connector of the tray and with their other end opening encompassing another upstanding connector.

154. Fig. 33 discloses a tray 560 like the tray 400, Fig. 21 and like numerals indicate the same parts. Each end 402, 404 of the tray 560 has two spaced-apart upstanding connectors 562 useful for releasably attaching wear strips with appropriate openings (e.g., but not limited to, wear strips as in Figs. 28 - 32C and 38A - 41A, with appropriately sized openings) to the tray 560. Each connector 562 has a top 564 larger than a base 565 so that, e.g., upon sliding an opening (e.g., but not limited to an opening 513 of the wear strip 510, Fig. 28) around a connector 562, the top 564 abuts a top surface of the wear strip (which is made with an appropriate thickness) thereby holding the wear strip in position. One, three or more such connectors 562 may be used (with a corresponding opening or openings in a wear strip).

155. Figs. 34A and 34B show a wear strip 570 according to the present invention with a body 571 and an upstanding member 572. Holes 573 at each end of the body 571 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a side of a shale shaker mounting structure which has corresponding holes for the fasteners, etc. Holes 573 (and any hole in Figs. 35A - 37A) may be bevelled as shown.

156. Figs. 35A and 35B show a wear strip 580 according to the present invention with a body 581 and an upstanding member 582. Holes 583 at each end of the body 581 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a side of a shale shaker mounting structure which has corresponding holes for the fasteners, etc.

157. Figs. 36A and 36B show a wear strip 590 according to the present invention with a body 591 and an upstanding member 592. Holes 593 at each end of the body 591 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a

side of a shale shaker mounting structure which has corresponding holes for the fasteners, etc.

158. Figs. 37A and 37B show a wear strip 600 according to the present invention with a body 601 and an upstanding member 602. 5 Holes 603 at each end of the body 601 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a side of a shale shaker mounting structure which has corresponding holes for the fasteners, etc.

159. Figs. 38A and 38B show a wear strip 610 according to the 10 present invention which has a body 611 and an upstanding member 612 for receipt within a corresponding hole of a screen assembly. Using holes 613 at either end of the body 611, the wear strip 610 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 613 has, 15 optionally, a bevelled edge portion 614 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 615 of the openings 613 and then the wear strip is moved (to the left in Fig. 38A) to secure the wear strip in place with the connectors.

20 160. Figs. 39A and 39B show a wear strip 620 according to the present invention which has a body 621 and an upstanding member 622 for receipt within a corresponding hole of a screen assembly. Using holes 623 at either end of the body 621, the wear strip 620 is connectible to an end or side or crossmember of a shale shaker's 25 screen assembly mounting structure. Each opening 623 has, optionally, a bevelled edge portion 624 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 625 of the openings 623 and then the wear strip is moved (to the left in Fig. 39A) to secure the wear strip in place with 30 the connectors.

161. Figs. 40A and 40B show a wear strip 630 according to the present invention which has a body 631 and an upstanding member 632 for receipt within a corresponding hole of a screen assembly.

Using holes 633 at either end of the body 631, the wear strip 630 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 633 has, optionally, a bevelled edge portion 634 for ease of installation.

5 A connector on a shaker tray can be inserted through a generally round part 635 of the openings 633 and then the wear strip is moved (to the left in Fig. 40A) to secure the wear strip in place with the connectors.

162. Figs. 41A and 41B show a wear strip 640 according to the present invention which has a body 641 and an upstanding member 642 for receipt within a corresponding hole of a screen assembly. Using holes 643 at either end of the body 641, the wear strip 640 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 643 has,

15 optionally, a bevelled edge portion 644 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 645 of the openings 643 and then the wear strip is moved (to the left in Fig. 41A) to secure the wear strip in place with the connectors.

20 163. Fig. 42 shows a tray 650 according to the present invention for a screen assembly mounting structure of a shale shaker like the tray 400, Fig. 19, and like numerals indicate the same parts. The tray 650 has three holes 652 in each of its ends

402, 404. (Note that fluid flow over a screen assembly on the tray 650, and on any similar tray, may be from the top side 406 in Fig. 25 42 to the bottom side 406 in Fig. 42; or alternatively from end 402 to end 404). The holes 652 may be located, sized and configured for receipt therein of corresponding downwardly projecting members of a screen assembly or they may be used for releasably connecting

30 a wear strip according to the present invention to the tray 65 (or they may be used for receiving fasteners that pass through a screen assembly, as may be any hole in any tray according to the present invention).

164. Fig. 43 shows a tray 660 according to the present invention like the tray 400 of Fig. 19 and like numerals indicate the same parts. Each end 402, 404 has on its top surface an amount 662 of releasably cooperating hook-and-loop connection material and 5 each of two wear strips 664 has a corresponding amount 665 (see e.g. Fig. 44) of such releasably cooperating hook-and-loop connection material (e.g. but not limited to VELCRO™ material) for releasably connecting the wear strips 664 to the tops of the ends of tray 660. Each wear strip has an upstanding member 667 (like 10 the upstanding member 420, Fig. 19). The wear strips 664 are shown above the tray 400 over the positions on the tray 664 at which they are connected in use (as is true for the wear strips shown above the tray in Fig. 45).

165. Fig. 45 shows a tray 670 according to the present invention like the tray 400 of Fig. 19 and like numerals indicate the same parts. Each end 402, 404 has on its top surface an amount 672 of two-sided adhesive tape for adhesively and releasably securing each of two wear strips 674 to the tops of the ends of tray 670. Each wear strip 674 has an upstanding member 677 (like 20 the upstanding member 420, Fig. 19).

166. Fig. 46 shows a tray 680 according to the present invention like the tray 400, Fig. 19, and like numerals indicate the same parts. A wear strip 684 is secured on crossmembers 410, 412 as shown with any suitable securement, fastener, adhesive, 25 and/or welding. It is within the scope of this invention to have a wear strip according to the present invention on any crossmember or crossmembers of a shale shaker's screen assembly mounting structure.

167. Fig. 47 shows a tray 690 according to the present invention like the tray 400, Fig. 19, and like numerals indicate the same parts. A crossmember 412 has an upstanding member 692 for receipt within a corresponding hole of a screen assembly emplaced on the tray 690. Another crossmember 412a has a hole 693 for

receiving a downwardly projecting member of a screen assembly emplaced on the tray 690. Any number of holes 693 on any of the crossmembers may be used according to the present invention; and/or any number of upstanding members 692 may be used on any of the crossmembers. The hole 693 and upstanding member 692 may have any shape for holes and upstanding members, respectively, disclosed herein.

168. Fig. 48 shows a screen assembly 700 like the screen assembly 430, Fig. 20A, and like numerals indicate the same parts. One crossmember 432a of the frame 432 has a hole 703 sized, located and configured for receiving a corresponding upstanding member of a screen mounting structure of a shale shaker. A crossmember 432b of the frame 432 has a projecting member 702 for receipt within a corresponding hole in a screen mounting structure of a shale shaker. Any number of holes 703 may, according to the present invention, be used on a crossmember or crossmembers of the frame 432; and/or any number of projecting members 702 may, according to the present invention, be used on a crossmember or crossmembers of the frame 432.

169. Fig. 49A shows a projecting member 710 according to the present invention which may be used for any upstanding or upwardly projecting member or downwardly projecting member disclosed herein. The projecting member 710 has a base 712 larger than a top 714.

170. Fig. 49B shows a hole 720 in material 722 which has a top opening 724 larger than a hole bottom 726. Such a hole may be used for any hole in any embodiment of the present invention. The base 712 and top 714 (and the top opening 724 and hole bottom 726) may be any desired size, and the distance between them may be any desired length; and the shape of the top 714 and base 712 (and of the top openings 724 and hole bottom 726) may be any shape disclosed herein for an upstanding or upwardly projecting member.

171. Figs. 50A and 50B show a screen assembly 730 according to the present invention which has a plurality of glued-together

layers of screening material 731, 732, 733 with a plate 734 attached at one end and secured to the lower layer 733 of screening material. Holes 735 extend through the screening material layers and through the plate 734. The plate 734 may be adhesively secured
5 to the screening material and/or any suitable fastener and/or clamp apparatus may be used for such securement. The holes 735 may be used (as may the holes 743, Fig. 50C) as holes for receiving an upstanding member of a screen assembly mounting structure of a shale shaker; or fasteners may be inserted through the holes to
10 releasably secure the screen assembly to a shale shaker screen assembly mounting structure. As with the glued-together layers of the screen assemblies of Figs. 50C, 50E and 50G the screen assembly 730 (and any screen assembly for use with systems as disclosed in
15 Figs. 52A - 57) may be any combination of two, three or more layers of screening material and/or mesh and/or support as disclosed in pending U.S. applications Ser. No. 10/037,474 filed 10/19/01, and Ser. No. 10/087,025 filed 10/19/01 entitled "Glued Screens For Shale Shakers" naming Thomas C. Adams, Kerry Ward, Kenneth W. Seyffert, David W. Largent, David L. Schulte, Jr., Charles N.
20 Grichar, Vincent D. Leone, Jeffrey E. Walker, and Guy L. McClung,
III as co-inventors, said applications incorporated fully herein in their entirety for all purposes.

172. Optionally, the screen assembly 730 has holes 736 through the screening material and through plates 737a, 737b; and, optionally, holes 738 through a plate 739. It is within the scope
25 of the present invention to provide a hole or holes on the outer periphery of the screen assembly 730 or to provide one or more holes with a corresponding lower plate (made of any suitable material including materials disclosed herein for wear strips and
30 projecting members, rigid or flexible) at an inner area of the screen assembly 730 (and as may be provided in the screen assemblies of Figs. 50C and 50E).

173. Figs. 50C and 50D show a screen assembly 740 according to

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the present invention which has a plurality of glued-together layers of screening material 742 (like the layers 731 - 733, Fig. 50B) and holes 743 through a plate 741 (like the plate 734, Fig. 50B). Optionally, a flexible seal flap 744 is provided along an 5 end (or side) of the screen assembly and it is within the scope of the present invention to provide such a flexible seal flap on the opposite side or end (or on any side or end of any known screen assembly) for sealing a screen-assembly-basket-wall interface when the screen assembly is in position in a shale shaker basket. A 10 hook apparatus 745 is connected to one end (or side) of the screen assembly 740 and provides a hook structure that can be engaged by known screen mounting apparatuses. With pins or fasteners extending through the holes 743 to releasably connect the screen assembly 740 at one side of a screen basket, tension can be applied 15 to the screen assembly 740 through the hook apparatus 745 for efficient tensioning and positioning of the screen assembly on a shale shaker.

174. Figs. 50E and 50F show a screen assembly 750 according to the present invention which has a plurality of glued-together 20 layers of screening material 752 with plates 753, 754 on either side of the screen assembly 750. Downwardly projecting members 755 (which may be like any downwardly projecting members disclosed herein) project down from the plates 753, 754 and are sized, located, and configured for receipt in corresponding holes of a 25 screen assembly mounting structure of a shale shaker.

175. Fig. 50G shows a screen assembly 760 according to the present invention which has a plurality of glued-together layers of screening material 762 (like the layers 731 - 732, 742, and 752 disclosed above). An outer peripheral layer 763 of glue, adhesive, 30 and/or epoxy surrounds the screen assembly 760 and a plurality of spaced-apart holes 765 extend through the layer 763 and through the layers of screening material. (Alternatively the layers 763 and/or 764 may be made of material like that of any plate in Figs. 50A -

50F.) Optionally a layer 764 like the layer 763 is provided on the bottom of the screen assembly 760. Any one, two, or three sides of either layer 763, 764 may be deleted, e.g. if holes are desired on less than all sides of the screen assembly. A plate or plates (rigid or flexible) may be positioned above layers of screening material above any plate in Figs. 50A - 50F.

176. Fig. 51 shows a wear strip 770 (which may be any wear strip according to the present invention) which is made in a bowed shape as shown in Fig. 51 so that it will exert an upward force on a screen assembly mounted above it in a shale shaker. Alternatively, any wear strip according to the present invention which is flexible may be connected to a shale shaker screen assembly mounting structure so that it is bowed upwardly. It is within the scope of the present invention to employ an initially-bowed wear strip in a flattened position so that in such flattened position it exerts an upward force on a screen assembly above it. This can be useful when wedges or other screen holding items are used which are made of a material such as rubber or urethane which can shrink or lose some of its resiliency in use thereby loosening the mounting of a screen assembly in a shale shaker.

177. The present invention, therefore, in some and not necessarily all embodiments, provides a vibratory separator for separating components of material introduced thereto, the vibratory separator having a basket, a collection receptacle beneath the basket, a deck on the basket for mounting a screen assembly thereon, the deck having a plurality of deck pins projecting upwardly therefrom, a screen assembly on the deck, the screen assembly comprising screening material, the screening material having a plurality of openings therethrough suitable for the flow of fluid therethrough, the fluid from the material introduced into the basket, the screening material having a plurality of spaced apart screen holes therethrough, each screen hole having therein part of one of the deck pins, vibratory apparatus connected to the

vibratory separator for vibrating the screen assembly, and holding apparatus for holding the screen assembly on the deck with a part of a deck pin in each screen hole.

178. In such a vibratory separator, the screening material may 5 include a plurality of layers of screen mesh.

179. In such a vibratory the vibratory separator may be a shale shaker and the material may include drilling fluid with drilled cuttings entrained therein.

180. In such a vibratory separator there may be two side 10 ledges on spaced-apart sides of the basket, the side ledges positioned for supporting spaced-apart sides of the screen assembly, each side ledge having an upper surface inclined downwardly from a basket side toward an interior of the basket, each deck pin projecting upwardly from one of the side ledges, and 15 two spaced-apart edges of the screen assembly each having screen holes of the plurality of holes therethrough, each of said edges of the screen assembly resting on one of said upper surfaces.

181. Such a vibratory separator may have holding apparatus including two spaced-apart rails, each rail positioned movably 20 above one of the two side ledges, each rail selectively movable downwardly to abut an edge of the screen assembly and to push said edge against the upper surface of said side ledge thereby bending said screen assembly so that said edges assume an inclination corresponding to the inclined upper surface of said corresponding 25 side ledge, and the vibratory separator further having selectively movable apparatus for moving the rails downwardly against said edges.

182. In such a vibratory separator the deck may include curved support for the screen assembly and the rails hold edges of the 30 screen assembly against the side ledges so that the screen assembly is held in a crowned shape.

183. Such a vibratory separator of any of the above paragraphs may have one or some of the following, in any possible combination:

each rail having a plurality of rail holes therein, each rail hole located and configured for receiving a portion of a deck pin when the rail abuts the screen assembly, said deck pin also passing through an edge of the screen assembly; the holding apparatus 5 including two spaced-apart rails, one rail on each of two spaced-apart sides of the basket, each rail movable downwardly to abut an edge of the screen assembly, and movement apparatus connected to the basket for selectively moving the rails down to abut the screen assembly; power apparatus connected to the movement apparatus for 10 powering the movement apparatus for powered movement of the rails; the power apparatus including a plurality of selectively movable piston apparatuses above each rail, each selectively movable piston apparatus including a movable piston with a lower end releasably connected to a corresponding rail; manually operable apparatus for 15 selectively moving the rails; wherein the power apparatus is fluid powered by fluid under pressure; wherein the fluid under pressure is from the group consisting of gas (e.g. pressurized air and/or nitrogen) and hydraulic fluid; wherein the deck pins are canted away from side walls to the basket and toward an interior of the 20 basket and the holding apparatus includes two spaced-apart side members, each side member pushing down on an edge of the screen assembly thereby tensioning the screening material; wherein the holding apparatus includes a bladder system with inflatable bladder apparatus for pushing down on spaced-apart edges of the screen 25 assembly to hold the screen assembly on the deck; wherein the bladder apparatus directly contacts a top surface of the screening material providing a seal between an interface of a lower surface of the bladder apparatus and the top surface of the screening material; wherein the screen assembly has two edge hooks, one edge 30 hook at an outer part of each spaced-apart edge of the screen assembly held down by the holding apparatus, each edge hook releasably held within the basket; wherein the bladder apparatus directly contacts a top surface of the screening material providing

a seal between an interface of a lower surface of the bladder apparatus and the top surface of the screening material.

184. The present invention, therefore, in some and not necessarily all embodiments, provides a holding system for holding a screen assembly on a deck of a vibratory separator, the vibratory separator having two spaced-apart sides between which the screen assembly is held, the deck including two side supports for supporting two spaced-apart sides of the screen assembly, each side support having an upper surface inclined downwardly from its respective vibratory separator side toward an interior of the vibratory separator, the holding system having two spaced-apart rails, each rail located on a side of the vibratory separator above an upper inclined surface of a corresponding side support, each rail selectively movable downwardly to hold an edge of the screen assembly against an upper inclined surface of a side support thereby including said edge to assume an inclination corresponding to the upper inclined surface. Such a vibratory separator may have: rails with holes and each side support with a plurality of pins spaced-apart thereon and projecting upwardly therefrom from the upper surface, the pins for projection through the screen assembly and into the holes of the rails; the rails holding the screen assembly in sealing contact with the deck; and/or the holding apparatus wherein the screen assembly has screening material and downward force of the rails tensions the screening material of the screen assembly. A support for a screen assembly in a vibratory separator, the support having a deck for supporting a screen assembly, the screen assembly restable on the deck, the deck having two spaced-apart side supports, each of said side supports having an upper portion with an inclined surface, each of said inclined surfaces inclined inwardly and downwardly from an outer part of said deck toward an inner part thereof, each of said upper portions with said upper portions with inclined surfaces locatable beneath an outer edge of the screen assembly.

The present invention, therefore, in at least certain aspects, provides a screen assembly for a vibratory separator, the screen assembly having screening material having two spaced-apart outer edges, a plurality of spaced-apart holes in each of said outer edges, each of said holes located for receiving a portion of a pin projecting therethrough; and such a screen assembly may have the pin(s) projecting upwardly from a support beneath the screen assembly.

185. The present invention, therefore, provides a method for holding a screen assembly in a vibratory separator or shale shaker, the method including installing a screen assembly on a deck or support of a vibratory separator, the vibratory separator having two spaced-apart sides between which a screen assembly is held, the deck including two side supports for supporting two spaced-apart sides of a screen assembly, optionally each side support having an upper surface inclined downwardly from its respective vibratory separator side toward an interior of the vibratory separator, and holding the screen assembly in place with a holding apparatus, the holding apparatus having a holding system for holding the screen assembly on the deck of a vibratory separator, the holding system having two spaced-apart movable members, each located on a side of the vibratory separator above an upper inclined surface of a side support, and each movable member selectively movable to hold an edge of the screen assembly against an upper inclined surface of a side support thereby inclining the edge to assume an inclination corresponding to the upper inclined surface.

186. The present invention, therefore, provides a method for processing material with a vibratory separator, the method including introducing material to be processed to a vibratory separator, the vibratory separator including a basket, a collection receptacle beneath the basket, a deck on the basket for mounting a screen assembly thereon, the deck having at least one deck pin projecting upwardly therefrom, and the screen assembly having

screening material, the screening material having a plurality of openings therethrough suitable for the flow of fluid therethrough, the fluid from the material introduced into the basket, the screening material having at least one screen hole therethrough,
5 the screen hole for receiving part of one of the at least one deck pin, vibratory apparatus connected to the vibratory separator for vibrating the screen assembly, holding apparatus for holding the screen assembly on the deck with a part of said deck pin in said screen hole, and separating components of the material with the
10 screen assembly.

187. In conclusion, therefore, it is seen that the present invention and the embodiments disclosed herein and those covered by the appended claims are well adapted to carry out the objectives and obtain the ends set forth. Certain changes can be made in the
15 subject matter without departing from the spirit and the scope of this invention. It is realized that changes are possible within the scope of this invention and it is further intended that each element or step recited in any of the following claims is to be understood as referring to all equivalent elements or steps. The
20 following claims are intended to cover the invention as broadly as legally possible in whatever form it may be utilized. The invention claimed herein is new and novel in accordance with 35 U.S.C. § 102 and satisfies the conditions for patentability in § 102. The invention claimed herein is not obvious in accordance
25 with 35 U.S.C. § 103 and satisfies the conditions for patentability in § 103. This specification and the claims that follow are in accordance with all of the requirements of 35 U.S.C. § 112. The inventors may rely on the Doctrine of Equivalents to determine and assess the scope of their invention and of the claims that follow
30 as they may pertain to apparatus not materially departing from, but outside of, the literal scope of the invention as set forth in the following claims. Any patent or patent application referred to herein is incorporated fully herein for all purposes.